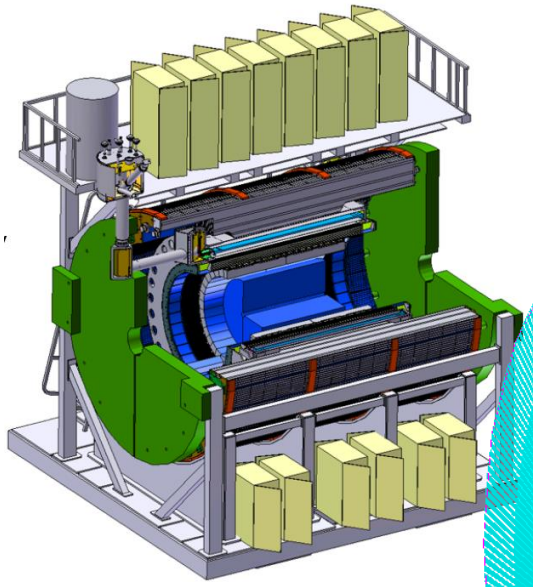
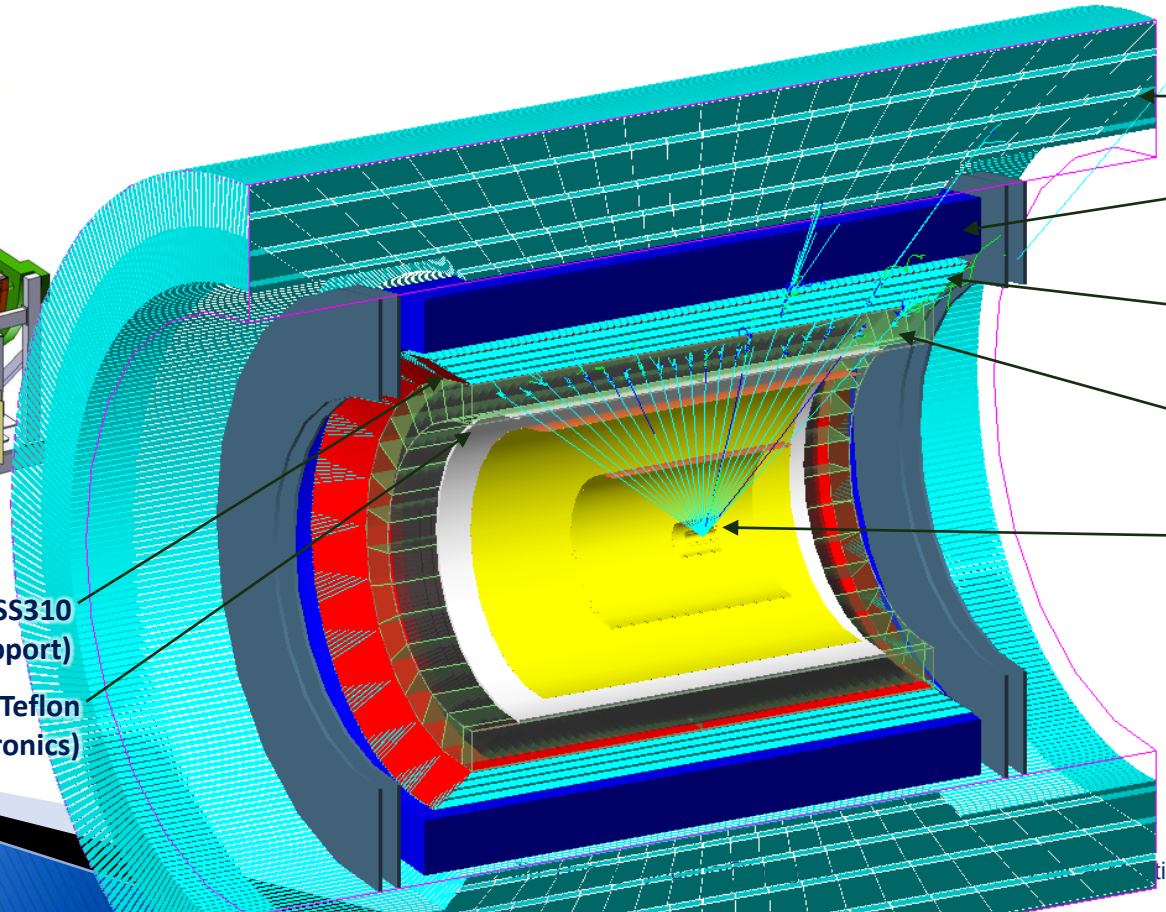
2D Projective SPCAL -> Geant4

Jin Huang (BNL)

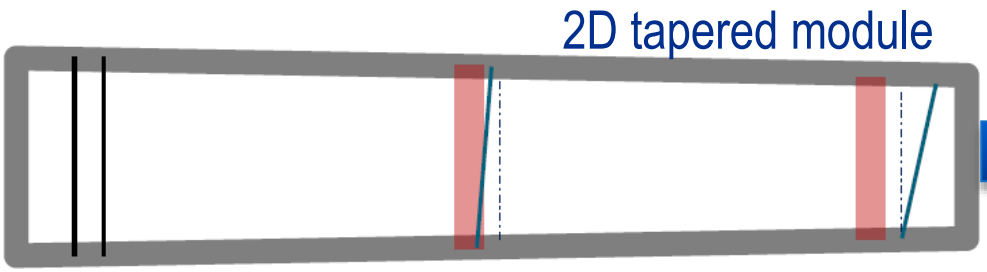
sPHENIX Calorimeters in Geant4

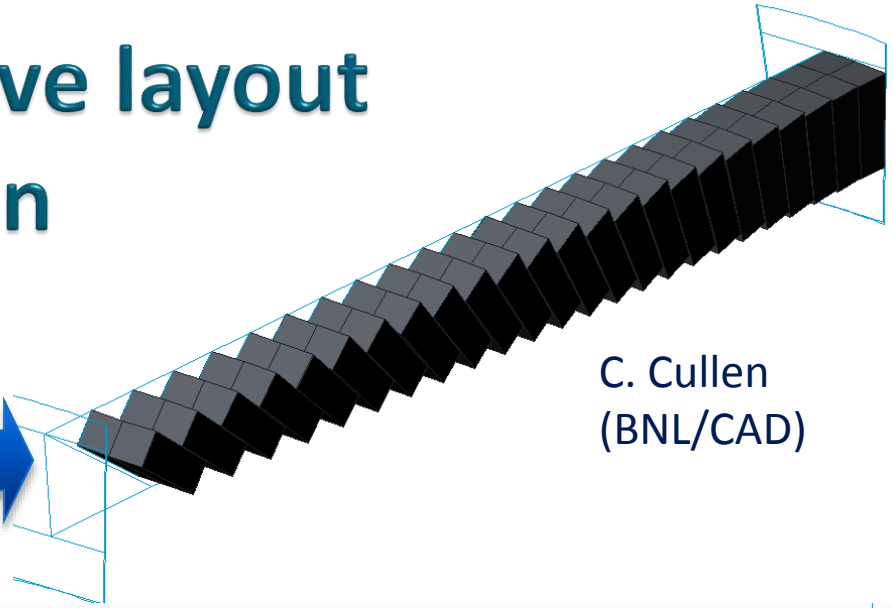
- EM calorimeter (EMCal) : 18 X_0 SPACAL
- Inner hadron calorimeter (inner HCal) : 1 λ_0 SS-Scint. sampling
- BaBar coil and cryostat. (BaBar): 1.4 X_0
- Outer hadron calorimeter (outer HCal) : 4 λ_0 SS-Scint. sampling



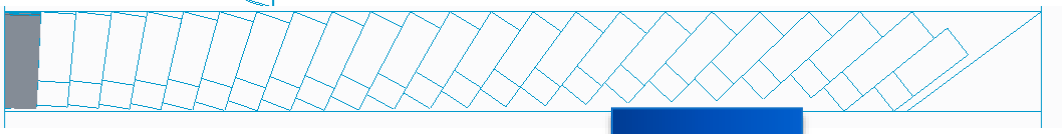


On-going: 2-D projective layout from CAD to simulation



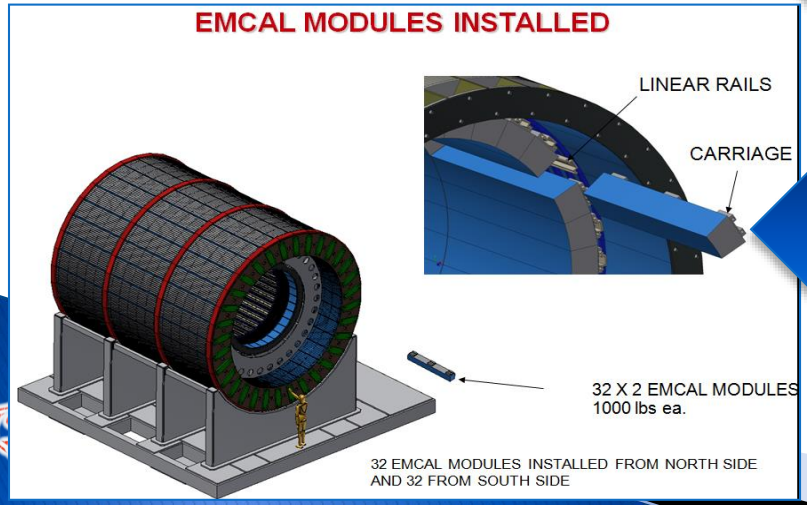


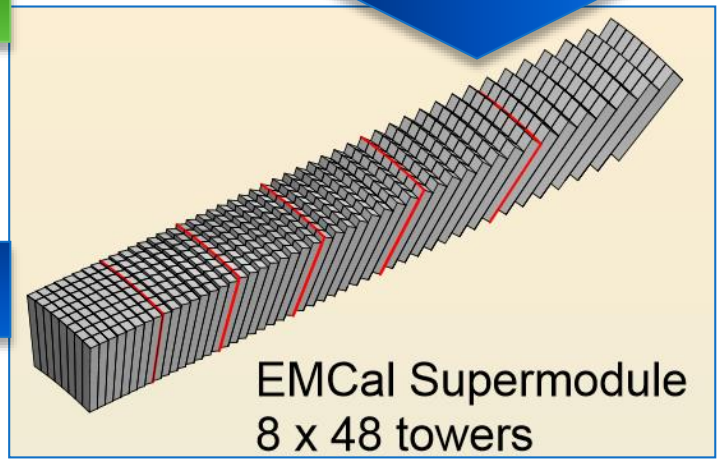
C. Cullen
(BNL/CAD)



Simulation for 2-D projective EMCal:
Plan to import the CAD geometry into sPHENIX Geant4

New

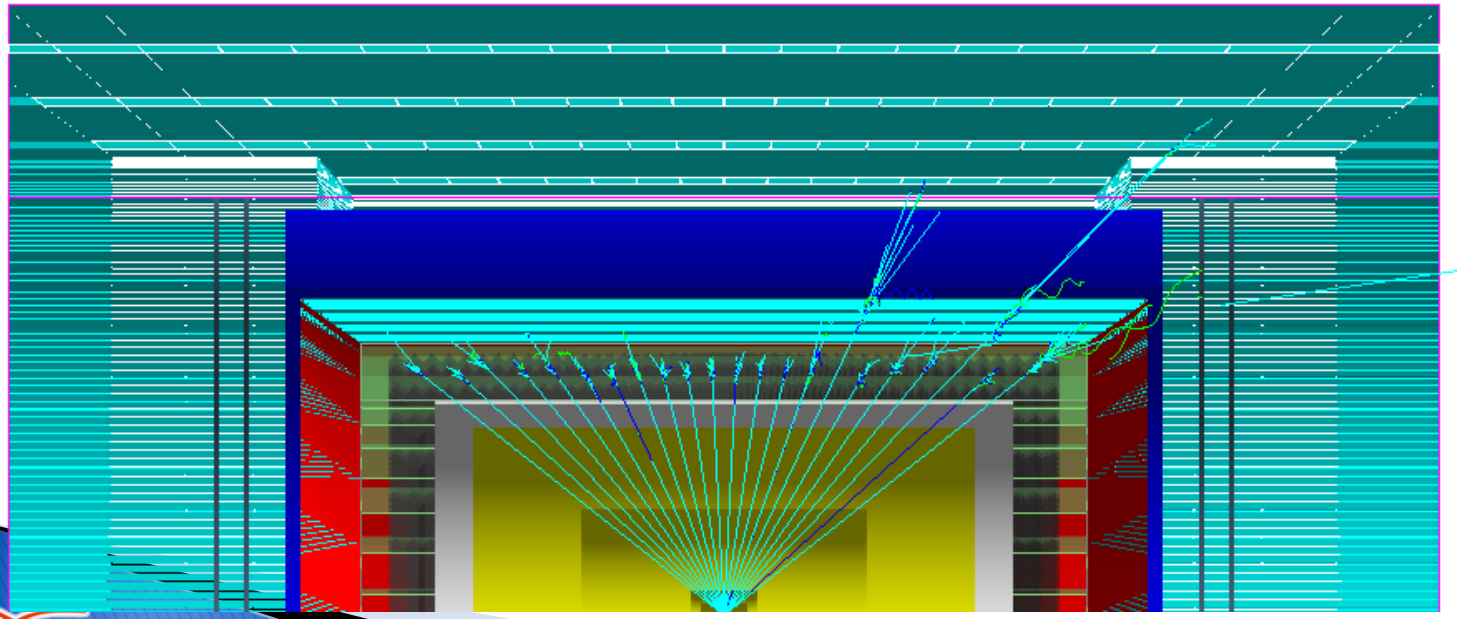


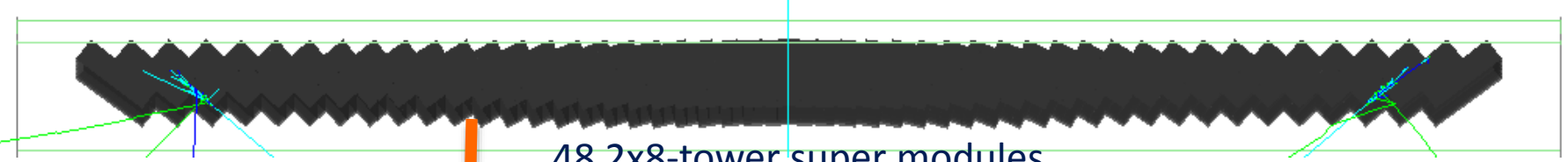


(Not yet updated to 2x2 block)

Implementation in Geant4

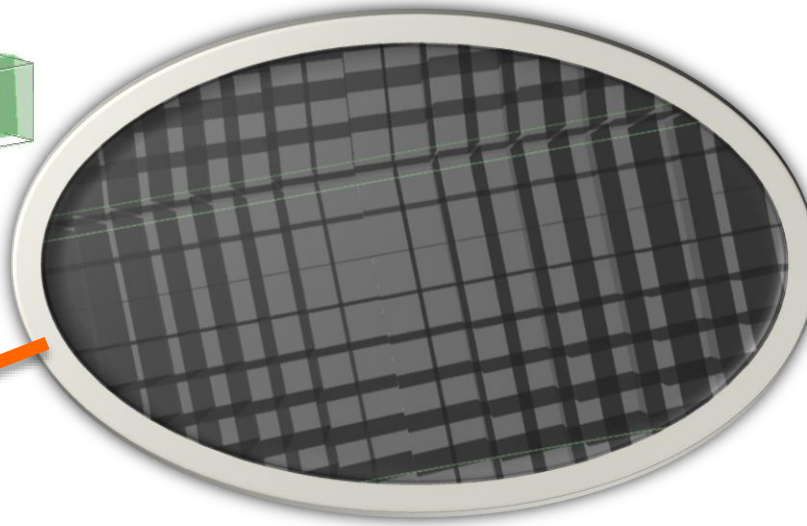
- Enabled with new branch 2DSpacal:
  - Not in nightly build by default (currently in evaluation)
  - To use: check out from GitHub:
    - https://github.com/sPHENIX-Collaboration/coresoftware/tree/2DSpacal
    - https://github.com/sPHENIX-Collaboration/macros/tree/2DSpacal
- After many optimization, currently still need ~5min to run the first event due to large number of unique geometry objects. Then ~2 EM shower/min

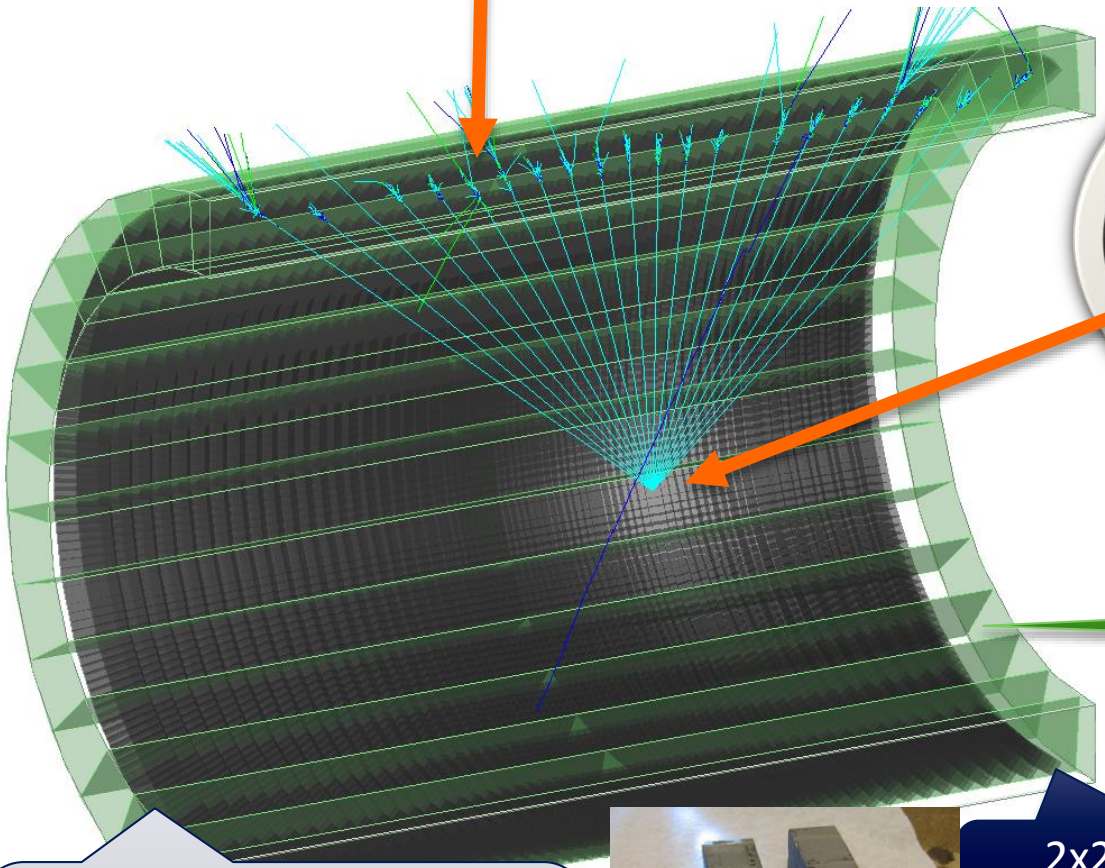




48 2x8-tower super modules

Towers project towards IP





Stainless steel SS310
Support box

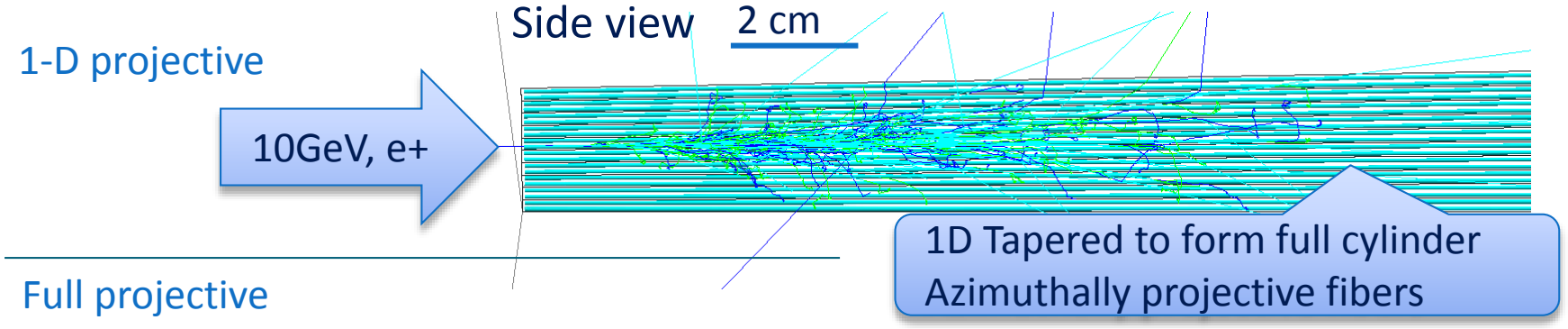
2x2 2D tapered
SPACAL modules

Gap between modules are also implemented

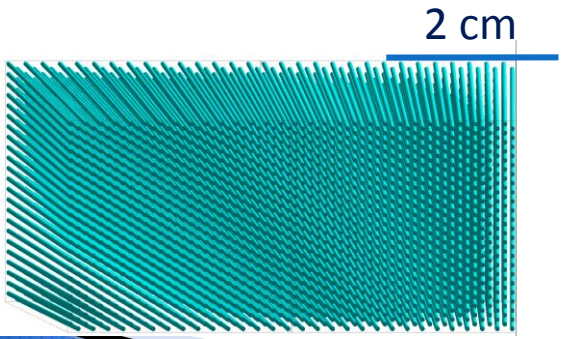
- 300um tolerance outside super modules skins
- ~2mil between SPACAL and SS skin
- ~2mil between SPACAL modules

Within a SPACAL module

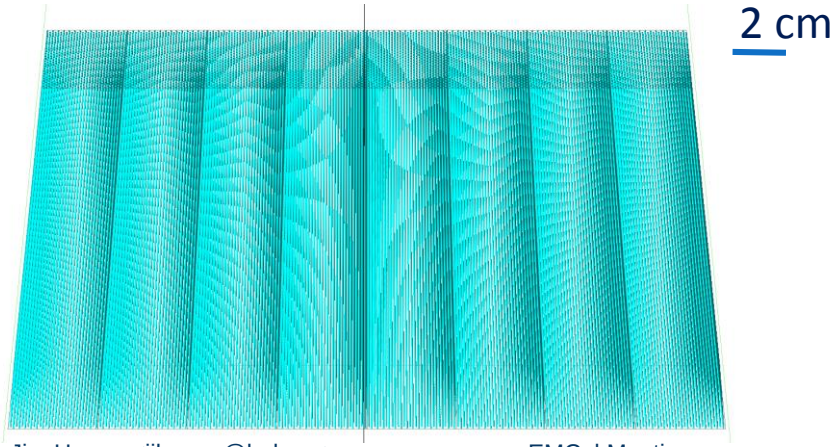
- Tungsten + Epoxy material: 12.18 * g / cm3, 96.9% mass with W
- Fiber: ϕ470um core (Polystyrene) + 15um skin (PMMA)
  - Thanks to the reference model from A. Kiselev (EIC taskforce & EIC RD1)
- Fiber matrix islayout in triangle pattern with a nominal separation of 1mm. Fiber at least 100um away from surface
- Default: 1-D projective in azimuth. New also available for test: full projective module



Particle view (2x1 modules)



Side view (8x1 modules)

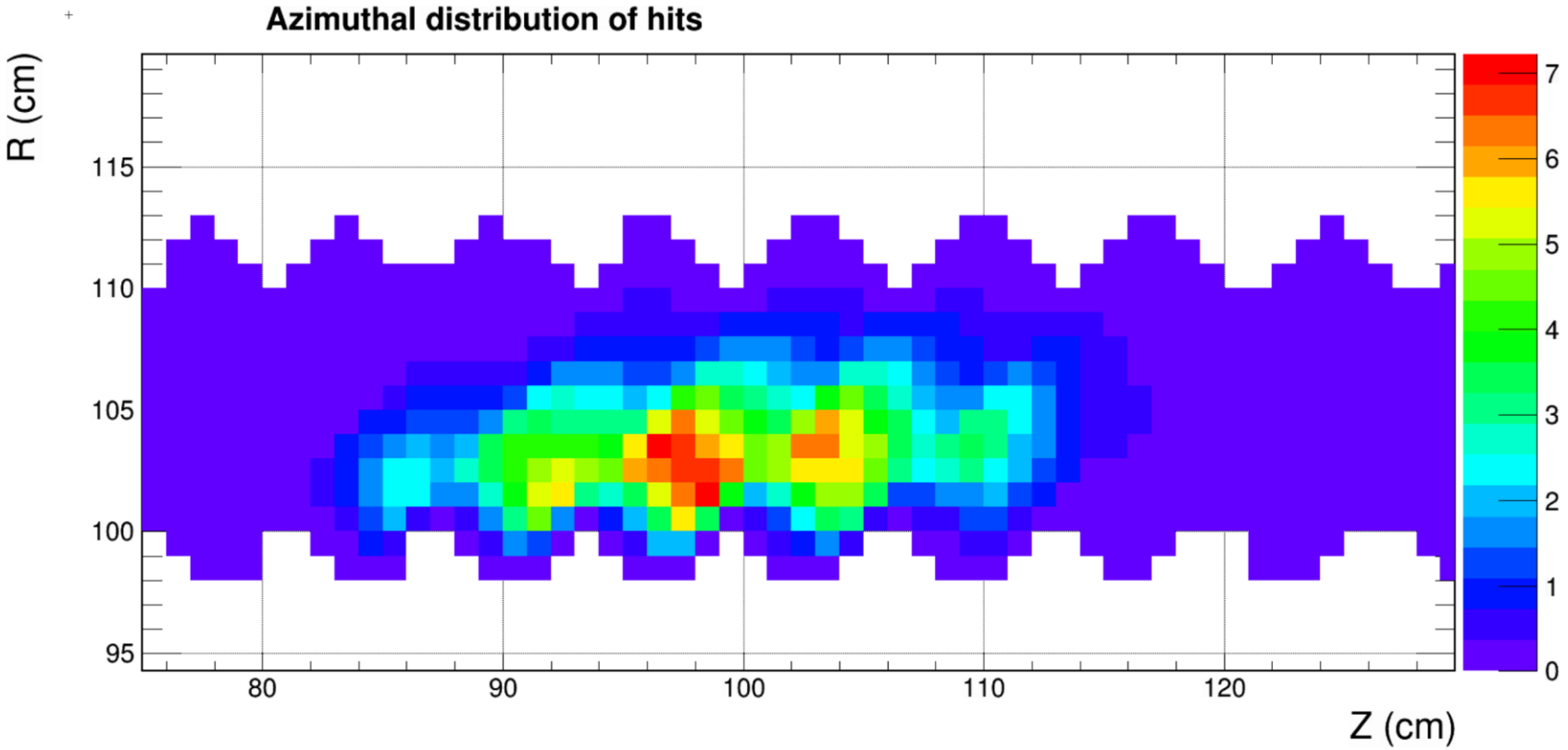


On-going works

- I am verifying the 2D projective setup and revise the performance plots
- Eliton Seidel (Baruch College) is verifying the parameters for Geant4 to model showers in SPACAL
- Nils Feege (SBU) is testing machine learning tools (boosted decision tree and support vector machine) on analyzing EMCal + innerHCal data.

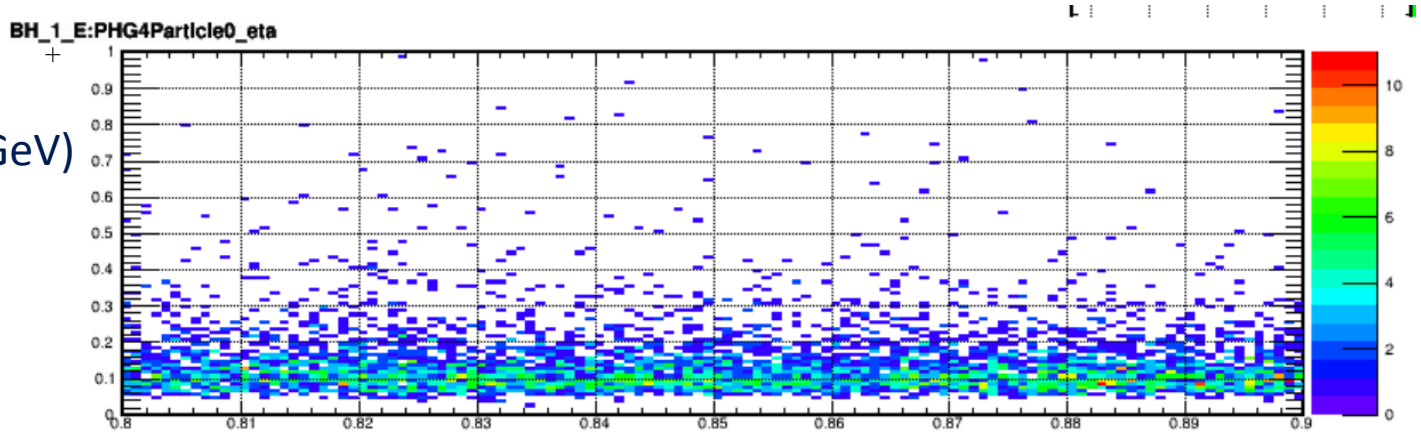
Extra Information

Energy distribution, p= 5GeV electron in sPHENIX field



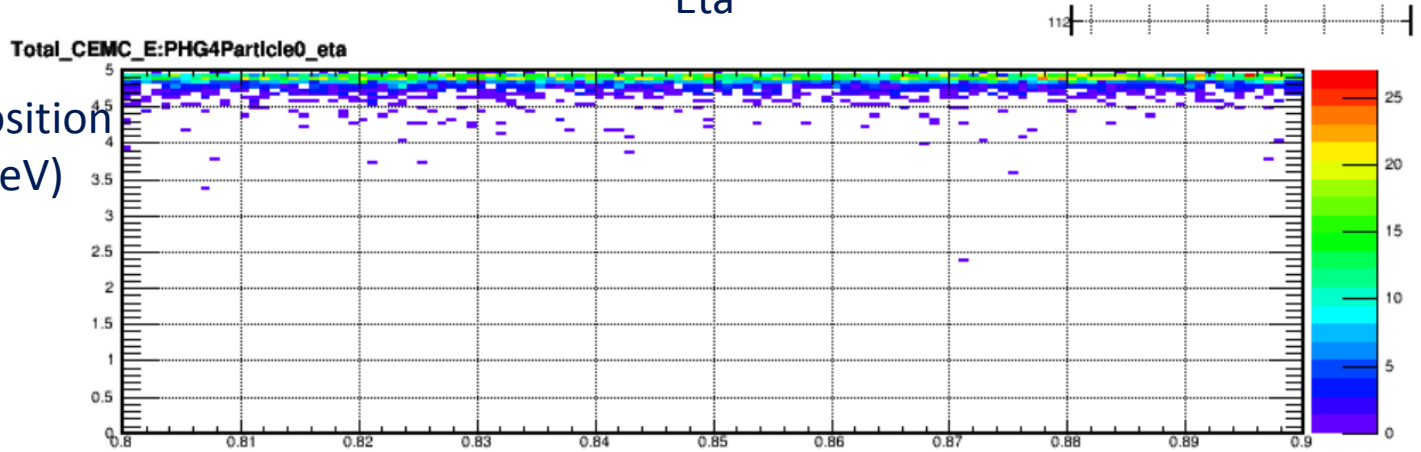
Looks smooth so far (vs eta)

Leakage (GeV)



Eta

Energy deposition in SPACAL(GeV)

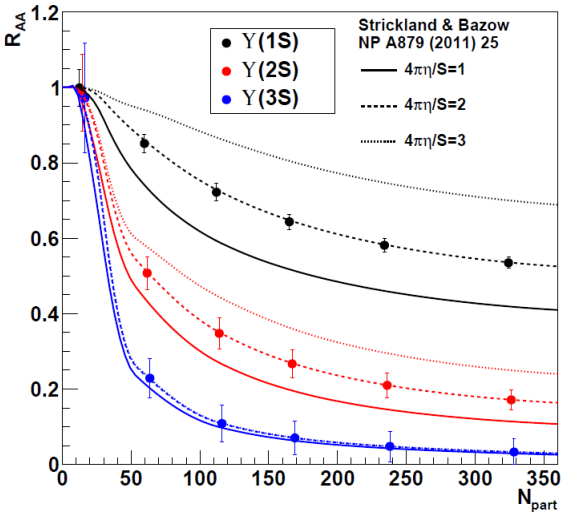


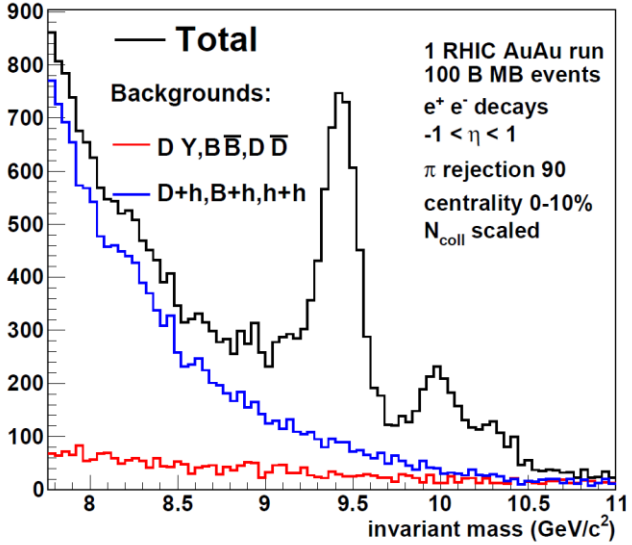
Eta

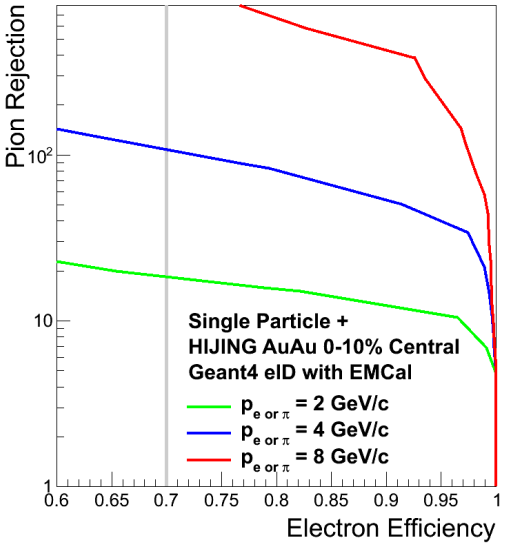
sPHENIX EMCal

1. Upsilon electron ID – main driving factor
2. Direct photon ID
3. Heavy flavor electron ID
4. Part of jet energy determination

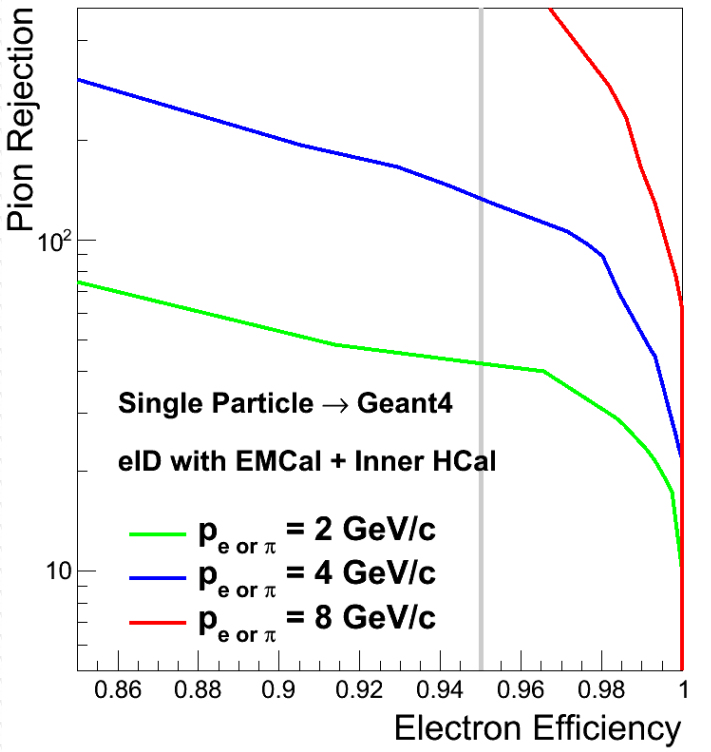
Upsilon R_{AA} → Hadron VS Upsilon → Hadron Rej. ~100:1

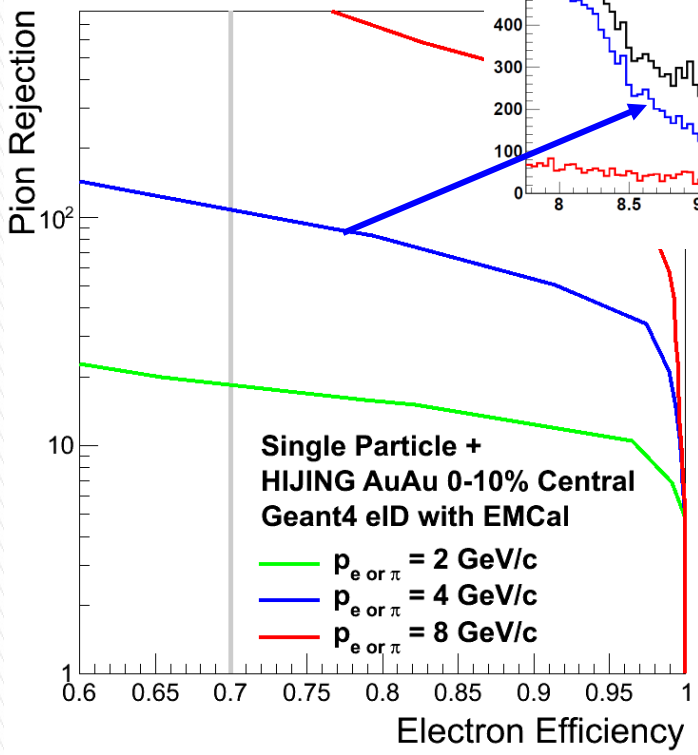


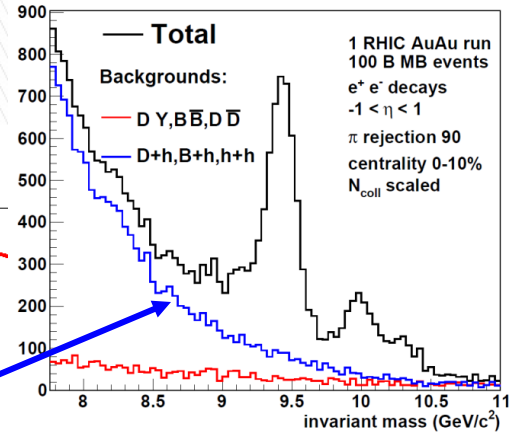




Compile everything together for barrel electron ID





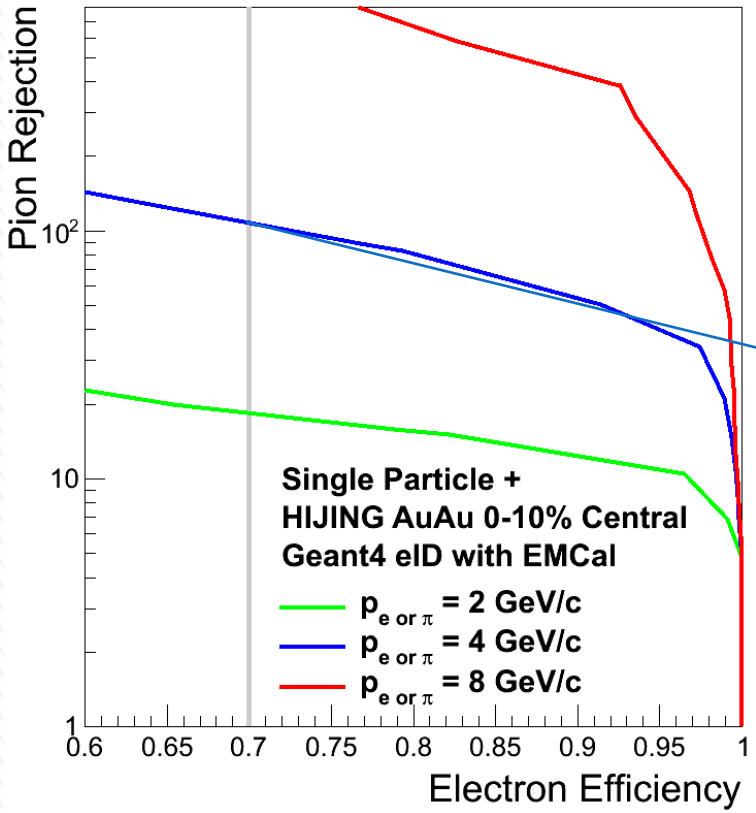


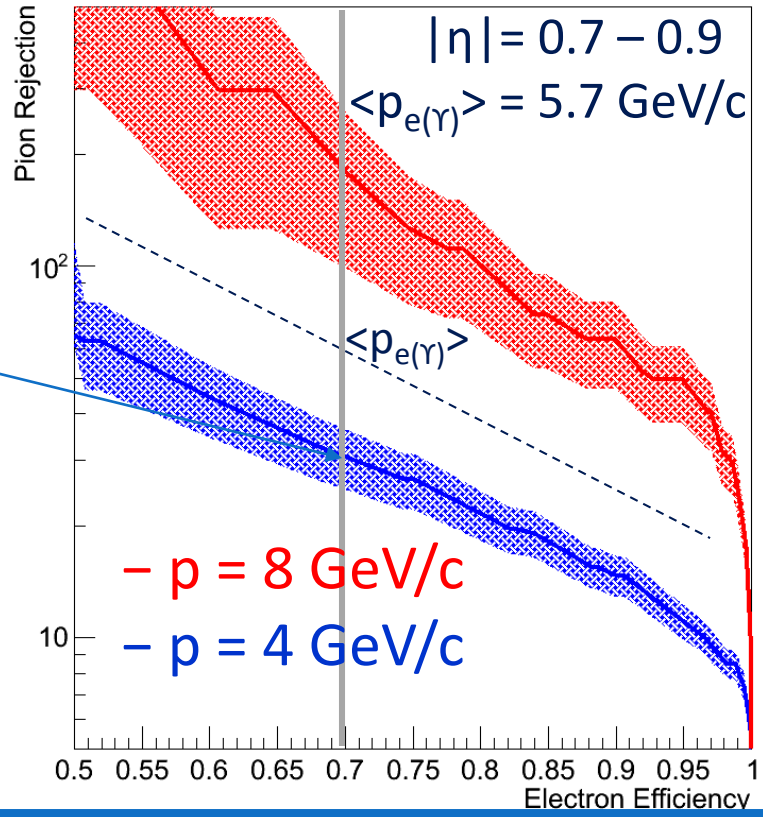
pp/ep electron ID (EMC+HCAL)

Central AA electron ID (EMC Only)

Fast group of Geant4 hit, need to re-evaluate in realistic towering!

Quantitative comparison for EID performance in Geant4 (group hits to simulate for towers)





Central rapidity, $|\eta| < 0.2$
Effectively projective in polar direction

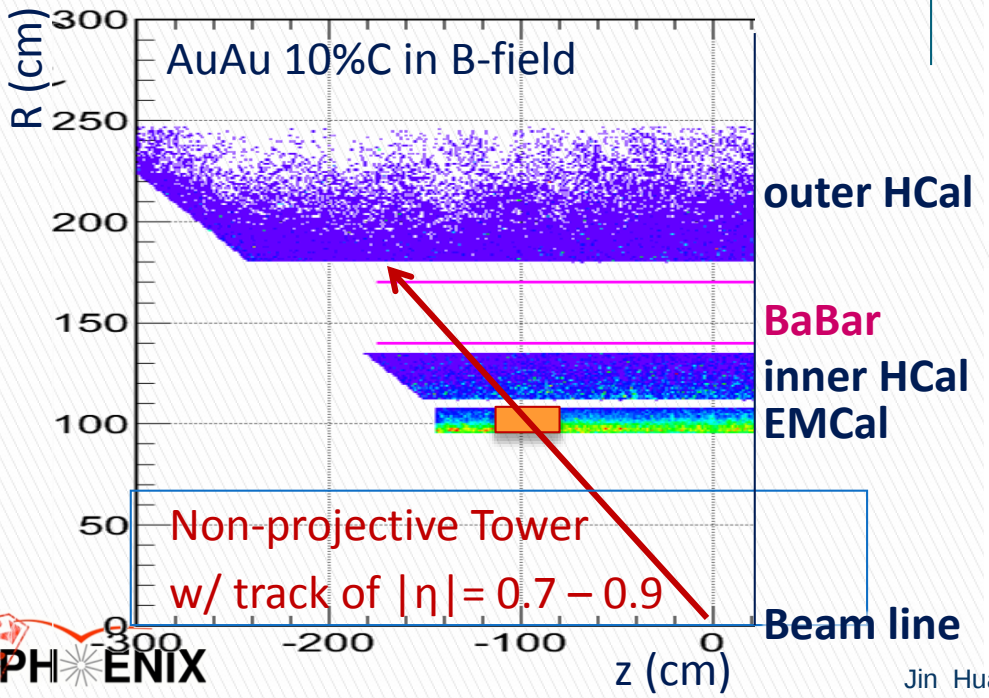
Forward rapidity, $|\eta| = 0.7 - 0.9$
non-projective in polar direction

Fast group of Geant4 hit, need to re-evaluate in realistic towering!

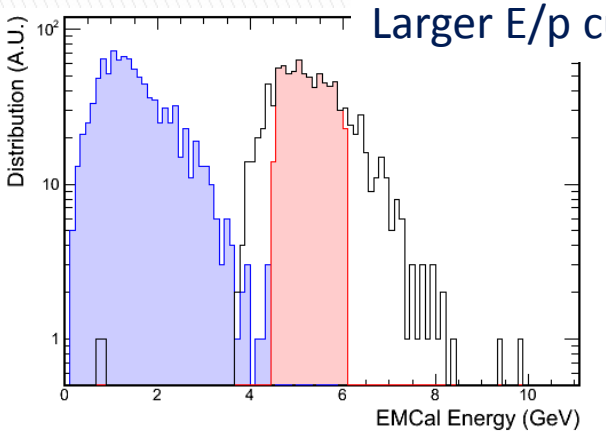
Larger pseudo-rapidity in central AuAu : under study

- Out of the box: larger |η|→ larger background
  - Longer path length in calorimeter
  - Covers more non-projective towers
- to improve
  - **Better estimate of the underlying background event-by-event (improve x1.5)**
  - **Use (radially) thinner ECal (improve x2)**
  - **Possibilities for projective towers?**

- all events (w/ embedding)
- with EMCal E/p cut (w/ embedding)
- Hijing background (AuAu 10%C in B-field)

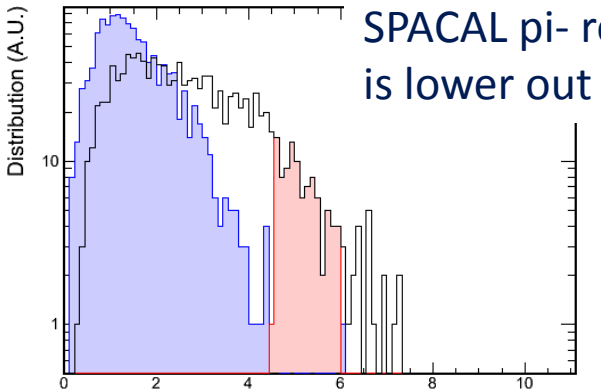


SPACAL e- Larger E/p cuts



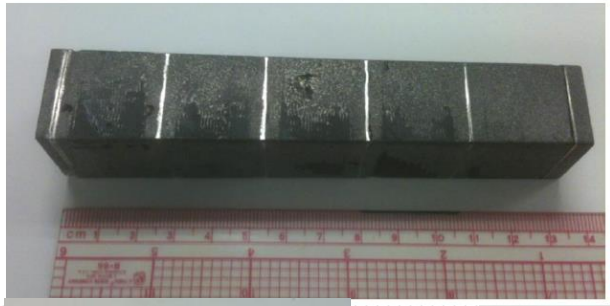
Out of box rejection ~10:1

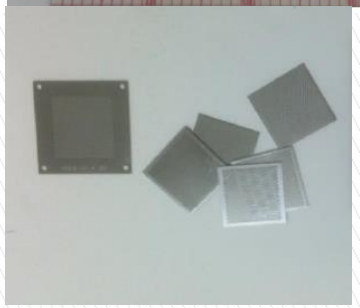
SPACAL pi- rejection is lower out of the box

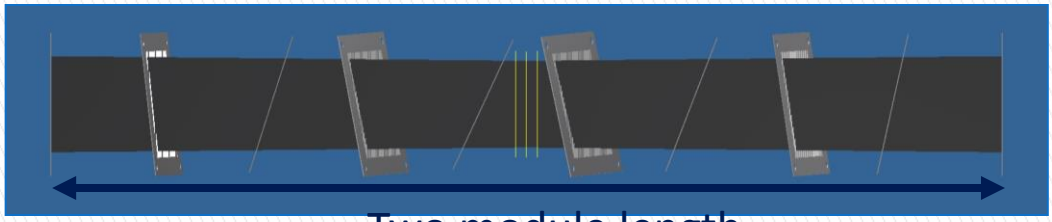


On-going R&D on 2D projective SPACAL

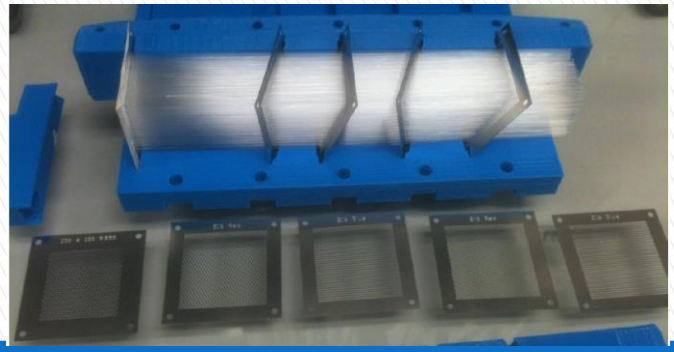
Sean Stoll (BNL), Spencer Locks (SBU), Jin Huang (BNL) and others







Two module length



R&D Direction 1:
Tapered step screens

R&D Direction 2:
Tilting Wireframes